Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

SPHENACODON MARSH, A PERMOCARBONIFEROUS THEROMORPH REPTILE FROM NEW MEXICO

By Samuel W. Williston

WALKER MUSEUM, UNIVERSITY OF CHICAGO

Received by the Academy, October 23, 1916

Thirty-eight years ago, O. C. Marsh gave the name *Sphenacodon ferox* to some jaws and vertebrae collected by David A. Baldwin near Arroya de Agua in Rio Arriba County, New Mexico. From his brief description it was suspected that the form was nearly allied to the remarkable reptiles known as *Dimetrodon* Cope, from the Permian of Texas, and a study of the type collections in the Yale Museum enabled me a few years ago to confirm the suspicion. The locality whence the type specimens came had almost been forgotten till five years ago, when Mr. Paul Miller, Prof. E. C. Case and I rediscovered the original bone-bed of Baldwin about a mile and a half above the confluence of the Poleo creek with the Puerco, and near the Mexican village of Arroya de Agua. Numerous specimens were obtained from this deposit, fixing the identity of the forms with those of other remains obtained from a bone-bed in the same horizon and a half mile nearer the mouth of the Poleo. From this bone-bed or 'bone-quarry,' discovered by Mr. Miller, numerous isolated bones of *Sphenacodon* and *Ophiacodon* Marsh, together with a very perfect skeleton of the latter, were obtained, but lack of time prevented a thorough exploitation of the deposit.

The past season my son, Samuel H. Williston, and I spent a few weeks in the same region, securing some very interesting and important specimens, a detailed description of which will be published later, including the material upon which the accompanying figure is based.

The 'Miller bone-bed' is in a hard, dark brown clay, which is worked with some difficulty because of the heavy embankment over it. It extends for about 100 feet along the foot of the high hills bordering the Poleo, and bids fair to yield not a few more good skeletons. About 20 feet east of the spot that yielded the remarkable skeleton of *Ophiacodon* that has been described, a femur of *Ophiacodon* was observed protruding from the excavation made by us in 1911. Upon following it up, two skeletons were discovered, one of *Ophiacodon*, lying immediately upon another of *Sphenacodon*, with their ends reversed. The extreme tip of the skull of *Sphenacodon* had been removed and lost in our previous excavations. It is altogether possible that I am the one who is responsible for the mutilation, but I am quite willing to share the responsibility with Mr. Miller and Prof. Case!

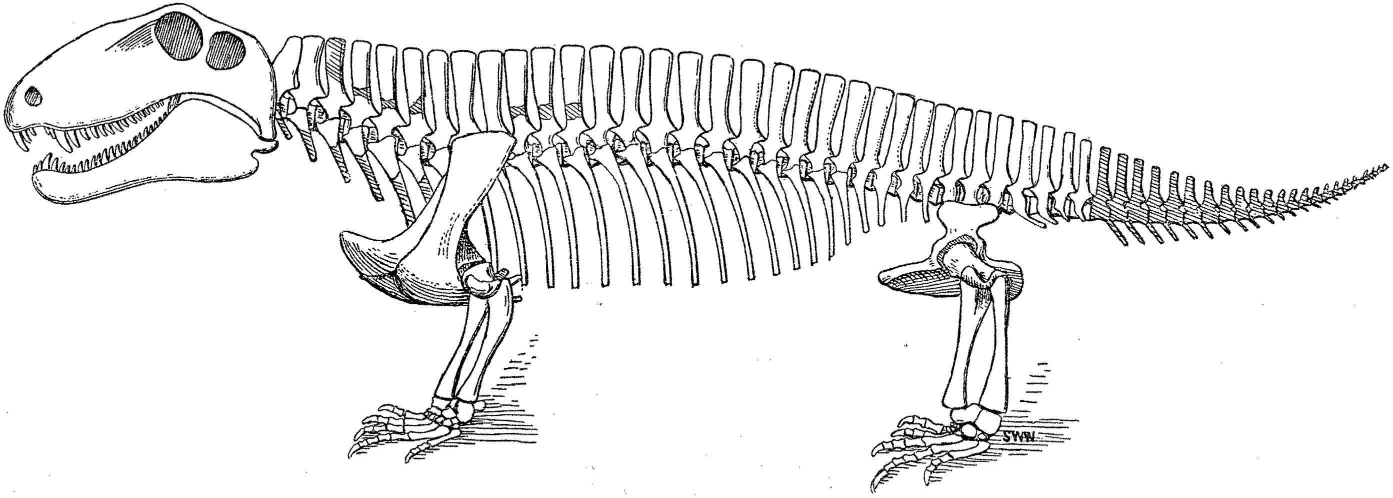

FIG. 1.—SPHENACODON MARSH, RESTORATION OF SKELETON, ONE-EIGHTH NATURAL SIZE. THE SKELETON IS REPRESENTED IN A WALKING POSTURE.

Otherwise the skull is very complete and but little distorted. Connected with the skull was a series of twenty-five presacral, three sacral and four caudal vertebrae, all closely united save for a break back of the eleventh vertebra, where there was an interval of a few inches, in which was found a single centrum and two connected spines, fixing the series as not less than twenty-seven presacral vertebrae. An additional spine, or twenty-eight in all was collected with the specimen, but inasmuch as isolated vertebrae are not rare in the deposit it is possible that the twenty-eighth spine does not belong in this series, but its close agreement with the adjoining spines makes it probable that it does, making twenty-eight presacral in all. In the accompanying restoration, however, only twenty-seven have been given, the number so commonly found in allied genera.

In collecting the vertebrae lying in the loose shales near the surface of the embankment, some fragments were lost connecting the spines, which, however, were attached to each other by the thin hard matrix with which all the bones were covered. These missing parts, which will doubtless be recovered in the excavated material next season, have been represented by oblique lines.

With this series of vertebrae, extending to the fourth caudal, were found parts of the girdles and limb bones which had been more or less lost by exposure, or the previous excavations. The preserved parts, however, are sufficient to determine their close agreement in size and characters with more perfect specimens found isolated near by. Of the feet nothing has been determined with certainty in this quarry, but the general agreement of the other parts of the skeleton with corresponding parts of *Dimetrodon*—except the vertebrae—make it practically certain that these parts are not appreciably different. As in *Dimetrodon*, the tail is, for the most part, unknown, and, as also in *Dimetrodon* the parts actually preserved in position leave little or no doubt of its relative shortness.

The spines of *Sphenacodon* are of nearly uniform length to the base of the tail. Those of the neck increase a little, both in thickness and length to the beginning of the dorsal region above the scapula, where they are the longest and stoutest in the whole series. They decrease very slightly in length posteriorly and grow thinner and less stout. With the first presacral they become markedly thinner and narrower and with the caudals grow rapidly more slender and shorter, leaving little doubt of the weakness and shortness of this part of the body. The vertebrae here also are shorter and smaller than those in front of them.

The ends of the cervical ribs have been lost, but with those exceptions they are preserved throughout the column, and not a few of them have been mended more or less completely. They are relatively slender for the size of the animal, and but little curved. Their unusual length was unexpected. The rib of the fifteenth vertebrae, for instance, measures more than ten inches. Inasmuch as the depth of the body is fixed by the girdles these ribs show decisively a broad body. The width back of the fore-legs could not have been less than twenty inches, or nearly a half of the length of the body to the sacrum, and may have been more. The length of the twenty-second, or fifth presacral, rib is seven inches. In the cervical and dorsal region they articulate by two well separated heads, the tubercle with the diapophysis, which is prominent, the head with the intercentral space. Near the middle of the back the broad head is less markedly dichocephalous, and their movability was less. With the seventh or eighth presacral they begin to show sutural union with the diapophysis and a facet on the front end of the centrum. At the fifth presacral the sutural union is obliterated and the ribs were fixed and immovable. As in *Dimetrodon*, the ribs extend back quite to the sacrum, the first presacral pair having an expanse of not less than six inches. Perhaps this unusually broad body is another reason for the short tail.

In a previous paper it was observed that the articular surface at the proximal end of the humerus in *Ophiacodon* has a spiral form, as is usual in the pelycosaurs, and that, in life the humerus could not have been depressed much below the horizontal without dislocation from the socket. Mr. Watson has called attention to this peculiarity of the American theromorphs and cotylosaurs, and has suggested that it explains the unusual expansions of the ends of this bone in these animals. It has been assumed that the remarkably broad and stout humeri of the cotylosaurs and pelycosaurs meant burrowing habits, but I have shown the error of this assumption in the fact, that, for the most part, the front legs are short, the fingers scarcely reaching as far forward as the end of the beak. Certainly an animal that could not reach in front of its nose would have difficulty in excavating a hole for the body to enter, unless it temporarily removed its head! The legs were carried, for the most part, with the elbow bent at a right angle, and the movement of the foot backward and forward in this position would account for the spiral motion in the glenoid socket. Furthermore, such a position of the limbs would require, for the support of the body, strong and broad muscular attachments on the humeri, a sufficient explanation of their shape.

Nearly every detail of the skull has been worked out and will be described and illustrated later. Suffice it to say here that the presence of quadratojugals, dermosupraoccipitals and tabulars has been definitely determined, and the supratemporals almost as definitely, thus giving to the genus nearly every skull element found in the most primitive cotylosaurs. The mandibles may be a little less slender and there may be fewer teeth but one can say with assurance that were an isolated skull of *Sphenacodon* found in Texas it would be referred unhesitatingly to *Dimetrodon*. And this similarity extends to other parts of the skeleton, with the exception of the spines of the vertebrae.

Many and various have been the conjectures offered to explain the extraordinary spines in *Dimetrodon*. In my opinion nothing better has been suggested than that of Professor Case, namely, that they represent an ornamental or senile character of the race, of no profound importance in the life economy of the animals. Certainly, as I have previously observed, if the spines of *Dimetrodon* had been of important use to their possessors they must have produced correlated differences in other parts of the skeleton. The differences in the spines have no more than a generic value.

There are doubtless several species of *Sphenacodon* in the New Mexican beds, but the known remains from the Baldwin and Miller bonebeds seem all to belong to one species. From different horizons on the Puerco, however, large specimens are known, now preserved in the Yale Museum. The present specimen, which doubtless belongs to *S. ferox* Marsh, was nearly five feet long as figured. The Yale specimens indicate a form one-half larger, or about seven and a half feet in length, or of about the size of most specimens referred to *Dimetrodon incisivus*. *Sphenacodon* is definitely known only from the valley of the Puerco and its tributaries in New Mexico; not a fragment of it has been found in the El Cobre deposits scarcely a score of miles away. However, there are specimens in the Chicago collection from Texas that suggest very strongly its occurrence there, but definite proof is lacking.

ON VOLUME IN BIOLOGY

By Lawrence J. Henderson

CHEMICAL LABORATORY OF HARVARD COLLEGE

Received by the Academy, October 28, 1916

In one respect this subject is time-honored. Herbert Spencer and many others since his day have recognized the biological importance of the principle of similitude. Bulk increases as the cube of length; surface as the square. Hence the limitation of the size of cells, the